Pinole Creek Watershed Sediment Source Assessment:

A sediment budget approach highlighting watershed-scale sediment-related processes and supply to the Bay

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NRCS Natural Resources Conservation Service

Project Goals

In local watersheds throughout the Bay Area, landowners, stakeholders, agencies and regulators are facing many watershed-scale sediment-related issues such as erosion, degraded water quality, degraded aquatic habitat, and reduced flood conveyance. However, it is often difficult to track sediment to its source, and determine causes of sediment-related problems without detailed study and development of a sediment budget.

The San Francisco Estuary Institute in conjunction with the Contra Costa County Resource Conservation District and the USDA Natural Resources Conservation Service developed a sediment budget for the Pinole Creek Watershed during Water Year 2004. The project's main goals were to:

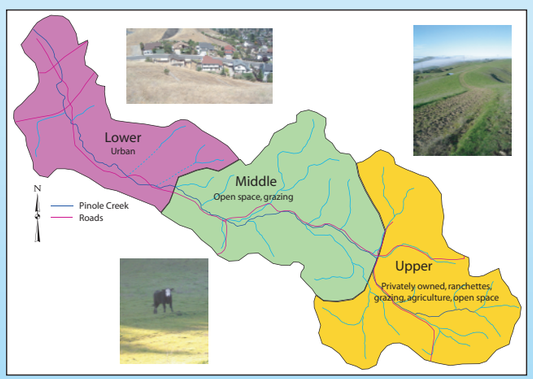
- Identify sediment sources in the watershed
- Estimate magnitudes and rates of sediment supply from each source
- Determine solutions for controlling sediment inputs and improving land management practices
- Address stakeholder concerns involving aquatic and wildlife habitat, water quality, flood conveyance, open space, and economic benefits of the watershed

Location and Watershed Description

The Pinole Creek Watershed is a 40 km² (15 mi²) watershed located in the East Bay Hills in western Contra Costa County. The underlying bedrock geology in the watershed is complex, comprised primarily of highly faulted and folded sandstones, shales and volcanic tuffs.

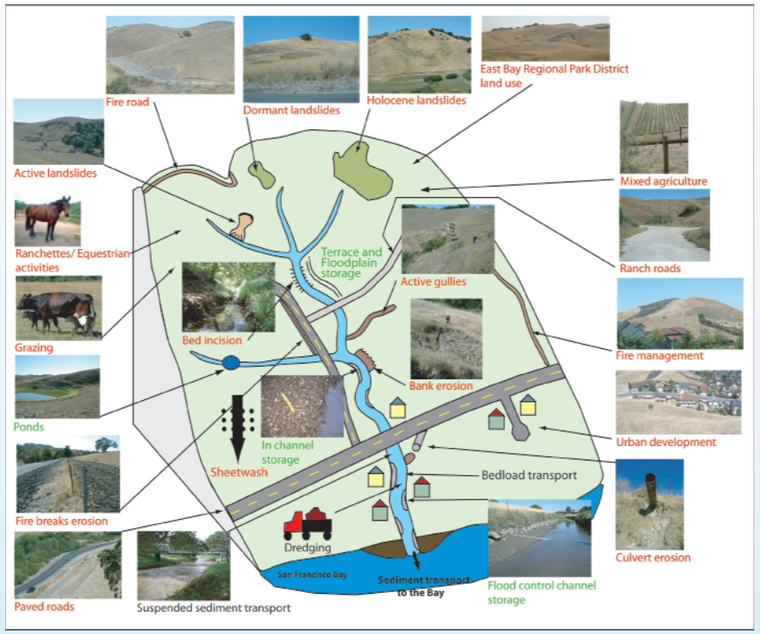
Historically, the watershed was primarily utilized for cattle grazing and agriculture, including hay production and tomatoes.

Currently, the Pinole Creek Watershed has three main land use types. The lowest third of the watershed is primarily urban, while the middle third is open space and grazed land, and the upper third is used for horse boarding, agriculture and open space.



Pinole Creek Watershed Sediment Processes Conceptual Model

A conceptual model was developed to illustrate our understanding of the geomorphic processes involving sediment sources, transport and storage that are occurring in the watershed. Sediment sources are labeled in **red**, sediment transport is labeled in **black**, and sediment storage is labeled in **green**.



Sediment Budget

Based upon the conceptual model, we developed a sediment budget for the creek. The watershed is divided into two parts: A. Pinole Creek upstream of I-80, and B. the Flood Control Channel downstream of I-80.

Sediment budgets are simple mathematical models that provide an understanding of the relative magnitudes of inputs, outputs and storage within defined systems. Just like balancing a checking account (**Income** - **Savings** = **Expenditure**) our sediment budget followed a similar equation:
Input - **Storage** = **Output** ± Balance ± Error

A Pinole Creek

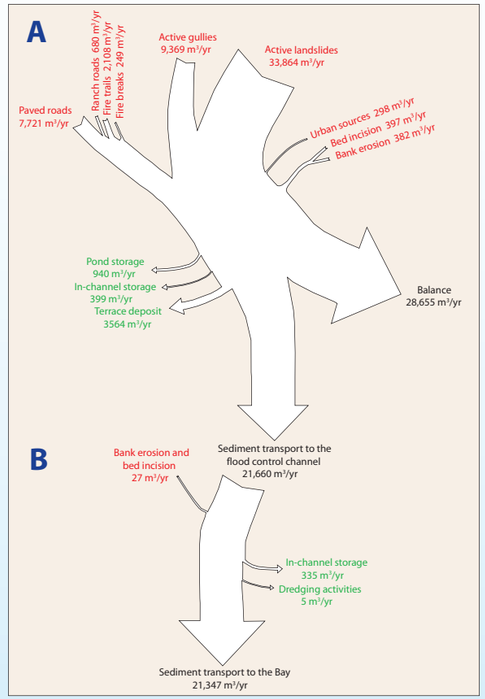
Holocene + Dormant + Active + Gullies + Roads + In-channel + Urban
-
Landslide deposits - Fans - Ponds - Bars - Terraces
=
Supply to flood control channel ± Balance ± Error

B Flood Control Channel

Supply to flood control channel
+
Channel erosion and incision
-
Aggradation - Dredging
=
Sediment transport to the Bay

Where: Holocene = Holocene landslides; Dormant = Dormant landslides; Active = Active landslides; Gullies = Active gullies; Roads = Input from paved roads, ranch roads, fire trails, and fire breaks; In-channel = Input from in-channel sources, including bank erosion and bed incision; Urban = Input from urban (commercial and residential) areas; Landslide deposits = Material disturbed by a slide, but remaining in storage on the hillslope; Fans = Hillslope colluvium stored in alluvial fans; Ponds = Sediment trapped by livestock ponds; Bars = In-channel sediment storage in bars, active channel deposits and pool deposits; Terraces = Storage in larger, older, more stable terrace deposits; Channel erosion and incision = Bank erosion and bed incision occurring in the flood control channel; Aggradation = Channel bed aggradation occurring in the flood control channel; Dredging = Removal of sediment via dredging activities in the flood control channel

The error term is the sum of all the errors of measurement or estimation of each budget term and is the primary reason why it is often difficult to balance a sediment budget. The Balance term accounts for all the volume that was not measured, or terms that were estimated, but thought potentially biased high or low. In this case, the Balance term is comprised of sediment storage in alluvial fans, colluvial hillslope deposits, and fluvial terraces. Also, this budget is averaged over a period of 50 years to smooth out the differing temporal and spatial variations in each of the source, transport and storage terms.



Findings and Recommendations

The dominant sources of sediment supply to Pinole Creek are active landslides, active gullies, and paved roads.

Hillslope sediment supply is in part due to the historic and current land uses and management overprinted upon the naturally highly erosive underlying geology and soil types.

A likely change in grassland vegetation may have occurred during the 1800s, resulting in a greater risk of soil erosion from overgrazing, and potentially initiating many of the dormant landslides, gullies, and mainstem incision that are observed today.

Other important sediment sources include urban areas, ranchettes and horse boarding facilities, fire trail and ranch roads, and in-channel sources such as bed and bank erosion.

Pinole Creek has very high suspended sediment concentrations during floods (up to 13,000 mg/L). For Water Year 2004, suspended sediment export is calculated as 252 t km^{-2}, approximately 2.5 times greater than the Bay Area average.

Sediment storage is occurring primarily in alluvial fans, colluvial hillslope deposits, and in fluvial terraces, comprising the Balance term in the sediment budget.

Once reaching the lower watershed, virtually all of the suspended sediment is transported through the flood control channel and into San Pablo Bay.

Recommendations for land management actions:

Stabilizing the actively eroding and extending gullies

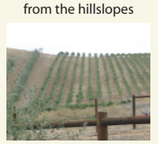
Controlling drainage from paved roads

Targeting the soil erosion sources to reduce suspended sediment concentrations and improve the overall quality of aquatic habitat

Work with horse boarding facilities to control surface erosion

Control the amount of erosion from existing active landslides, and prevent the triggering of new and dormant slides

Insuring that future development does not increase net runoff from the hillslopes



Acknowledgements

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